Web-Server Design Using Microblaze Processor Of Xilinx FPGA

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

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By

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CERTIFICATE

This is to certify that the thesis entitled, "Web-Server Design using Microblaze processor of Xilinx FPGA" submitted by Jyoti Prakash Das in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Electronics and communication at National Institute of Technology, Rourkela (Deemed University), is an authentic work carried out by them under my supervision.

To the best of my knowledge the matter embodied in the thesis has not been submitted to any University/Institute for the award of any Degree or Diploma.

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DECLARATION

I hereby declare that the work presented in the thesis entitled "Web server Design using Microblaze processor of Xilinx FPGA" is a bonafide record of the research work done by me under the supervision of Prof. Sarat Kumar Patra, Department of Electronics & Communication Engineering, National Institute of Technology, Rourkela, India and that no part thereof has been presented any other University/Institute for the award of any Degree or Diploma.

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ABSTRACT

Web server is an information technology which can be used for the purpose of communication to the client with the help of a website which acts as a web server at that time. Through the web server clients can access web pages, hypertext markup language documents, files and so on and they can be interconnected through this web server. The microblaze processor is a soft core processor having an intellectual property core which is implemented using logic primitives of the FPGA. The advantage of using the microblaze processor is that the soft core processor supports re-programmability and reconfigurability. The microblaze is a soft 32 bit RISC processor having wide variety of applications mainly in automobile, medical fields, industrial control system and we can use it also as a web server which the project aims. In this project, a soft core processor i.e. Microblaze based embedded system is developed with RS-232 serial interface, Ethernet interface, 32MB SDRAM, 4MB PROM (platform flash), 16x2 LCD interface, 8 digital inputs and 8 digital outputs. The embedded systems is connected to the internet and remotely controlled and monitored.

KEYWORDS : microblaze processor, Spartan 3e, FPGA, Ethernet, web server , softcore processor

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CHAPTER 1

INTRODUCTION

1.1 WEB SERVER

The technology used for the requests to be processed via Hypertext Transfer Protocol, the protocol used for information exchange throughout the web of internet world is called web server. The whole computer system, electronics appliances or any software that accepts and controls the protocols of Hypertext Transfer Protocol can be regarded as web server.

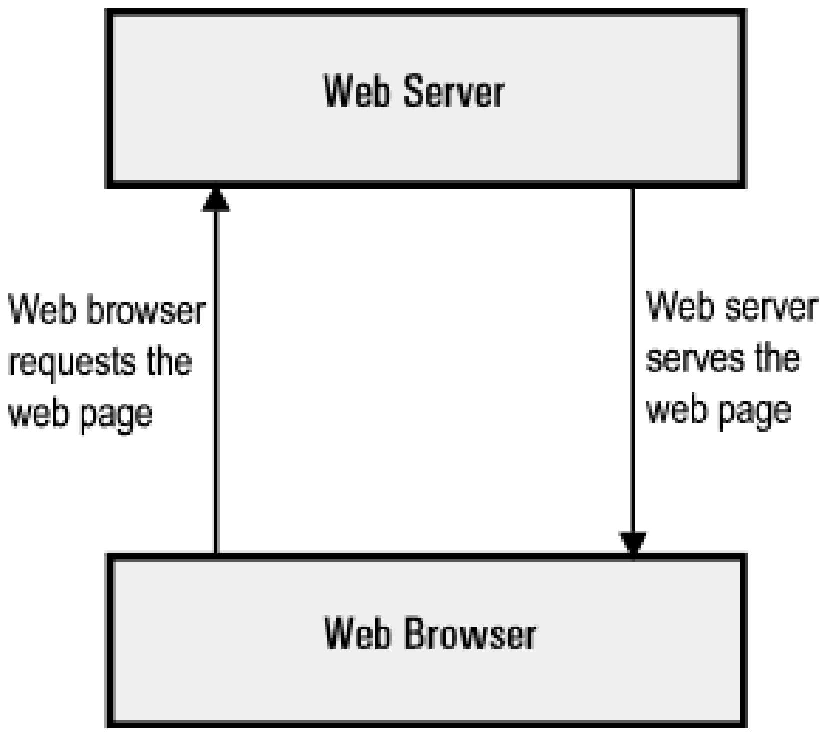

Figure 1-1 Communication between web server and browser through http protocol

Web server deals with the storage purpose, process and delivery of web pages to the clients. This communication process is established with the help of hypertext transfer protocol. The documents used in this process are mostly hypertext mark-up language documents which includes texts, images, sheets and various scripts. A web browser enacts a communication between server and the client by making a request using the hypertext transfer protocol and the response is generated by the server with the actual content of the specific resources or with an error message.

Figure 1-2 Several Networks interconnected through the web server

A full and actual implementation of web server includes getting contents from the clients for example receiving and sending including updated image file, audio file, video file, web forms, string contents emailing and sharing and so on.

1.2 MICROBLAZE_PROCESSOR

Microblaze is a soft processor core designed for Xilinx FPGAs (Field Programmable Gate Array) from Xilinx. Microblaze can be implemented as a soft core processor entirely in the general purpose memory and logic fabrication of Xilinx FPGAs. This processor contains over seventy user configurable options virtually enabling any type of processor use case from a very small footprint stage machine or system or microcontroller to a high performance multiple featured compute intensive micro based system. It is a processor which is built by the combination of blocks of codes which is called cores inside Xilinx field programmable logic array or FPGA. The architecture of this processor is a 32 bit Harvard Reduced Instruction Set Computer or RISC architecture, optimized to be implemented in Xilinx FPGAs with separate thirty two bit instruction and data buses running at optimum speed for the execution of programs and for the accession of memory on-chip and external memory at the same instant of time.

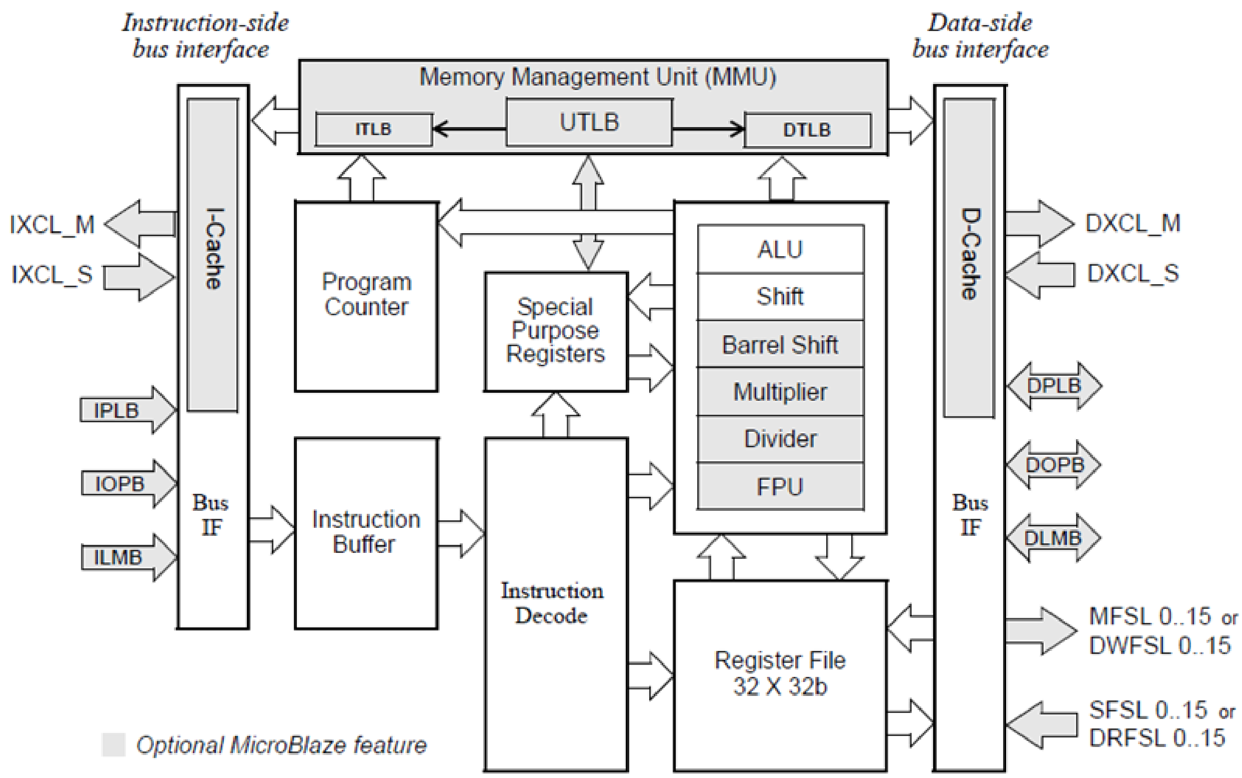

Figure 2-1 Architecture Design of microblaze processor

1.3 FEATURES OF MICROBLAZE PROCESSOR

The microblaze soft core processor has a property of highly configurable which allows us for the selection of specific features set which would be required for a design.

The fixed feature set of the microblaze processor includes the following :-

- Thirty two bit general purpose registers.
- Thirty two bit instruction word with three operands and two addressing modes.
- Thirty two bit address bus.
- Single issue pipeline.

1.4 XILINX SPARTAN 3E FPGA STARTER KIT

The basic features which is being provided with the Spartan 3E FPGA is also available in Spartan 3E FPGA starter kit. It provides the most simplest way for the test of various codes and programs in itself where we can dump the “bitstream” file into the FPGA and then we observe the output.

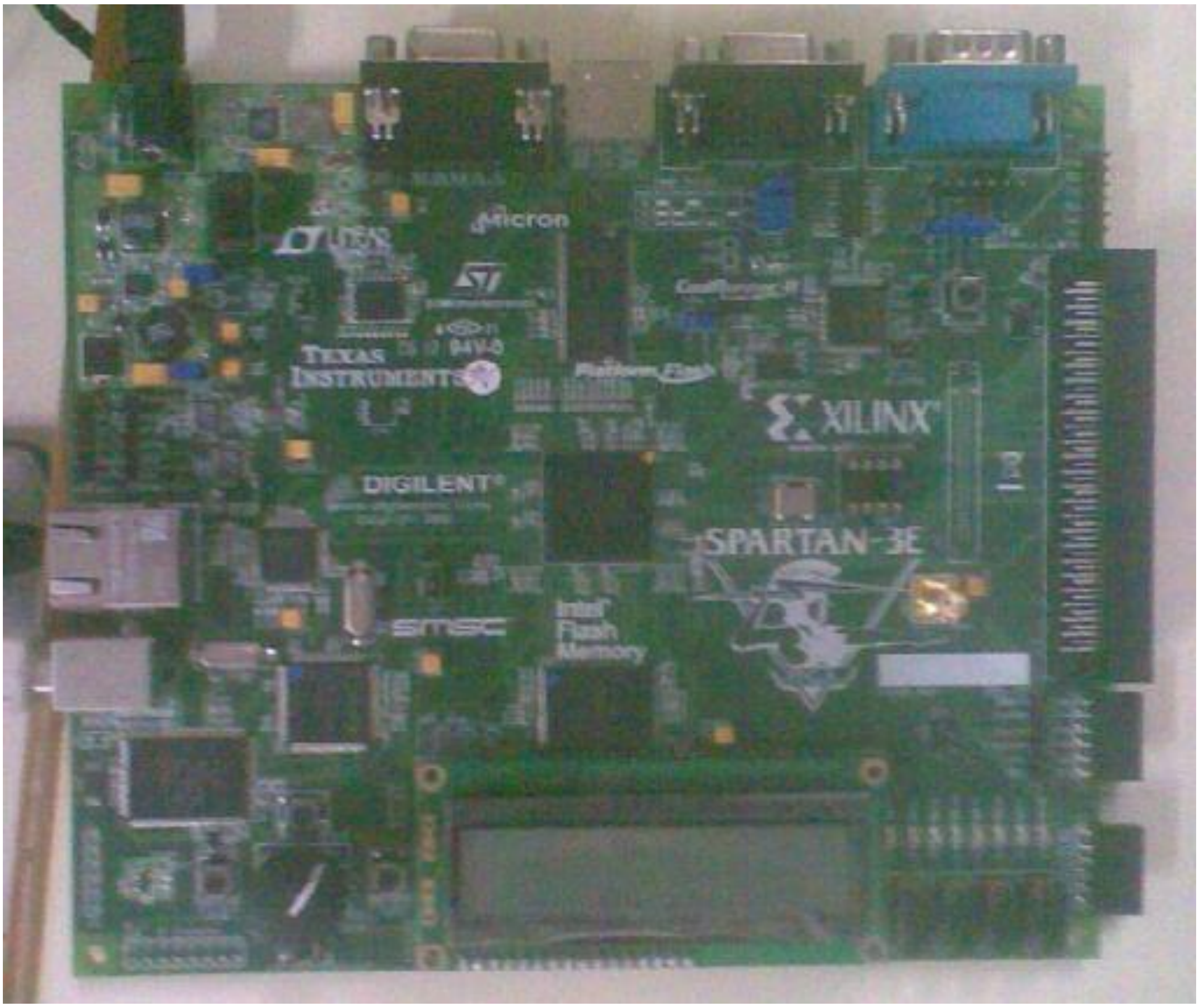

Figure 3-2 Spartan 3E starter kit

1.5 PERIFERALS AVAILABLE IN THE SPARTAN 3E STARTER KIT

Spartan 3e kit comes with many built in features and peripherals which is responsible for the perfect working of the board and for the interfacing of different signals into the board. The various built in peripherals available in the starter kit includes the following

- Two line , sixteen character LCD screen
- PS2 mouse or keyboard port
- VGA Display port
- 2 nine-pin RS232 port
- 50 MH clock oscillator
- FPGA Debug Interface
- 8 LEDs
- 4 DIP switches
- 4 push buttons
- 4 output SPI based DAC
- 2 input SPI based ADC

METHODOLOGY & FLOW DIAGRAM

CHAPTER 2

2.1 METHODOLOGY

The methodology I have adopted for the design of web server using the microblaze processor is mentioned below

(a) First of all we should have a basic understanding of the structure, design, working of the microblaze processor.

(b) After this we should have a basic understanding of the softwares, we would be going to use in our project. Such as Xilinx Platform Studio, Xilinx Base System Builder, Xilinx Software Developmet Kit .

(c) At first we would develop a basic processor with its peripherals using the Xilinx Platform Studio. This would include Microblaze (version 8.20.a), PLB_MDM, LMB BRAM controllers for BRAM, BRAM, UART for serial communication, MPMC controller for external DDR_SDRAM memory.

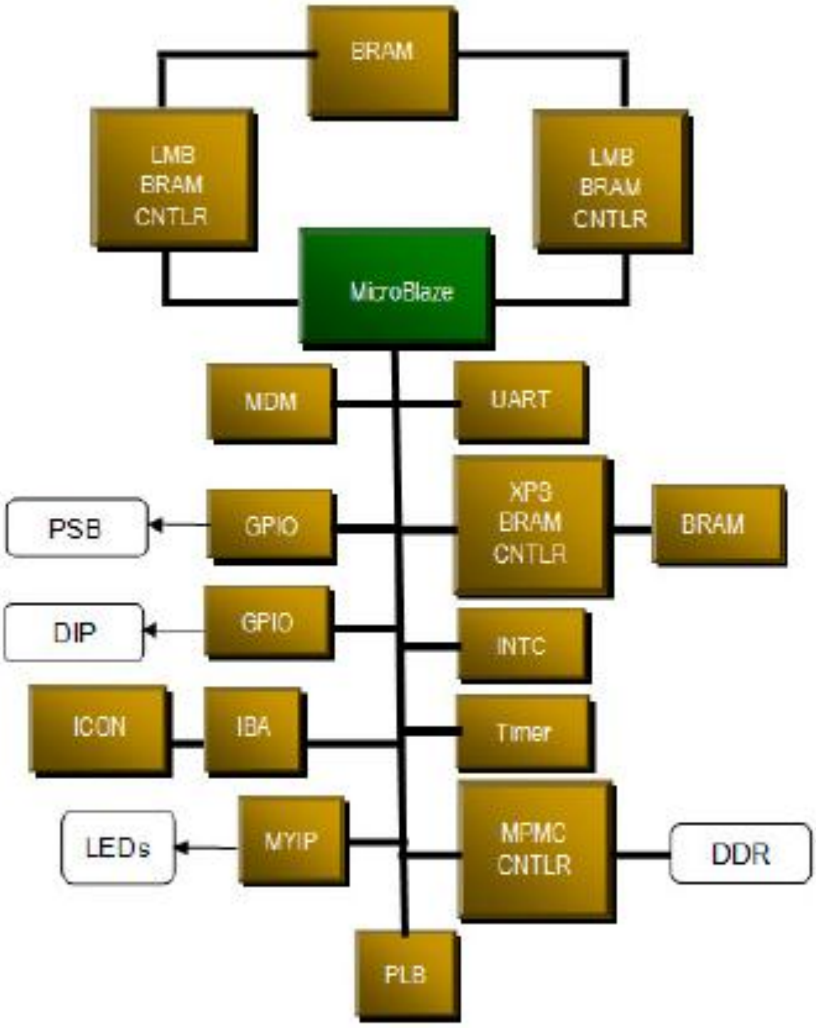

Figure 4-1 Completed block design of a simple microblaze processor based embedded system

(d) After this we are able to design a processor ip which can consist of DDR RAM .

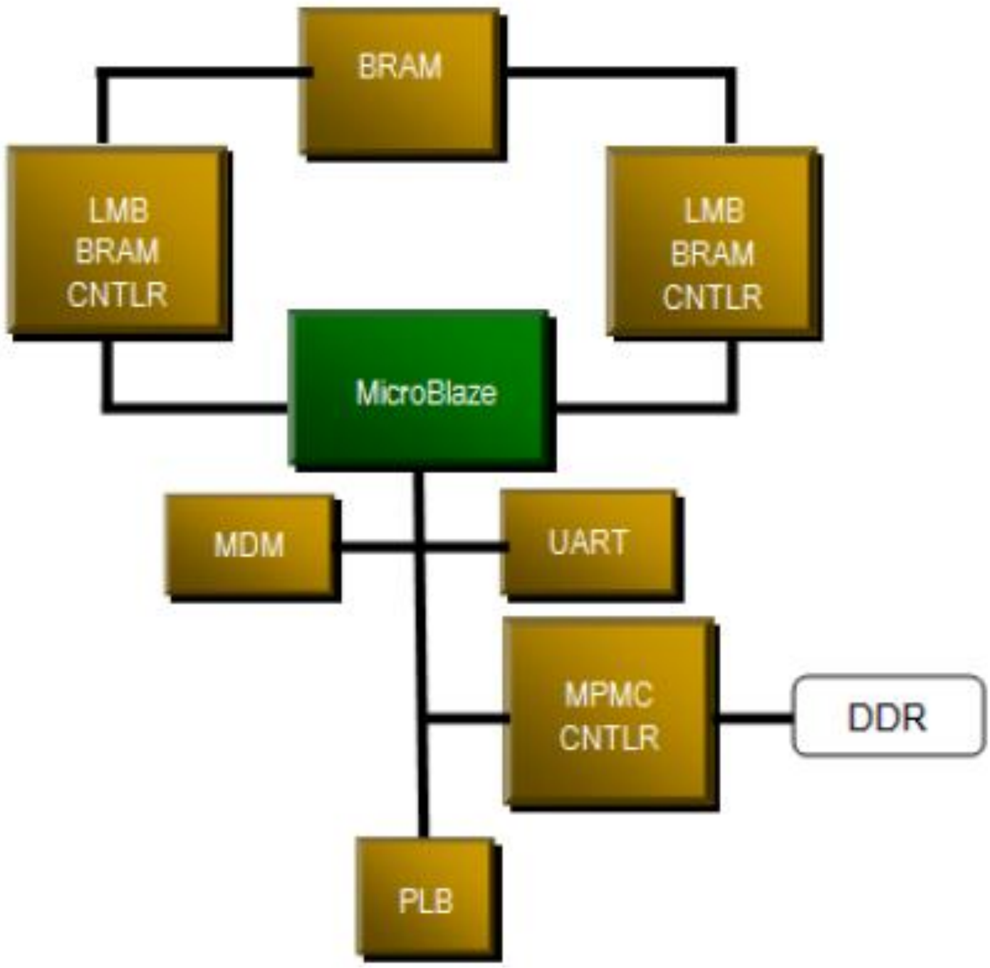

Figure 4-2 Block diagram of a processor ip consisting of DDR RAM

(e) Then we have to create a project in the Xilinx Platform Studio to toggle the LEDs of the Spartan 3E starter kit. The processor block diagram of this will as below

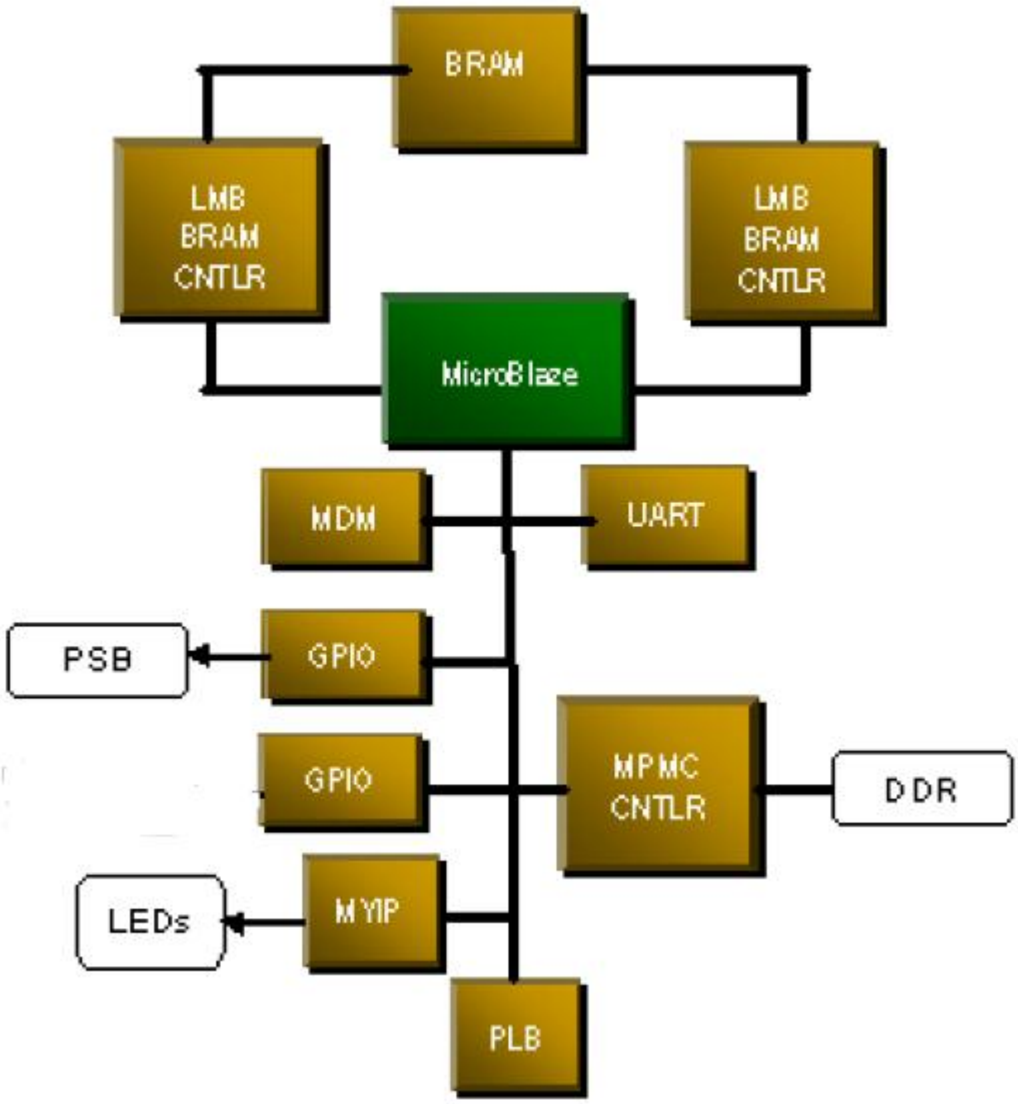

Figure 4-3 Block diagram of a processor ip consisting of LEDs

(f) After this the design of project is done in which we have to save an image file in the memory RAM of Spartan 3E starter kit.

(g) Then we designed a project to create a website using the C code in the Xilinx SDK which would act as a web server to toggle the LEDs of the Spartan 3E starter kit.

(h) In this project there are two ways for the communication of Transmission control protocol or internet protocol . They are RAW API and Socket API .

The socket mode provides a simple API
that blocks on socket reads and writes until they are completed. However, the socket API needs many pieces to achieve this .
Because this type of API contains much overhead for all operations, it is slow.

In another process RAW API gives a callback style interface to the applications. Applications using the RAW API
register callback functions to be called on significant events like accept, read or write. All work is done in the callback functions.

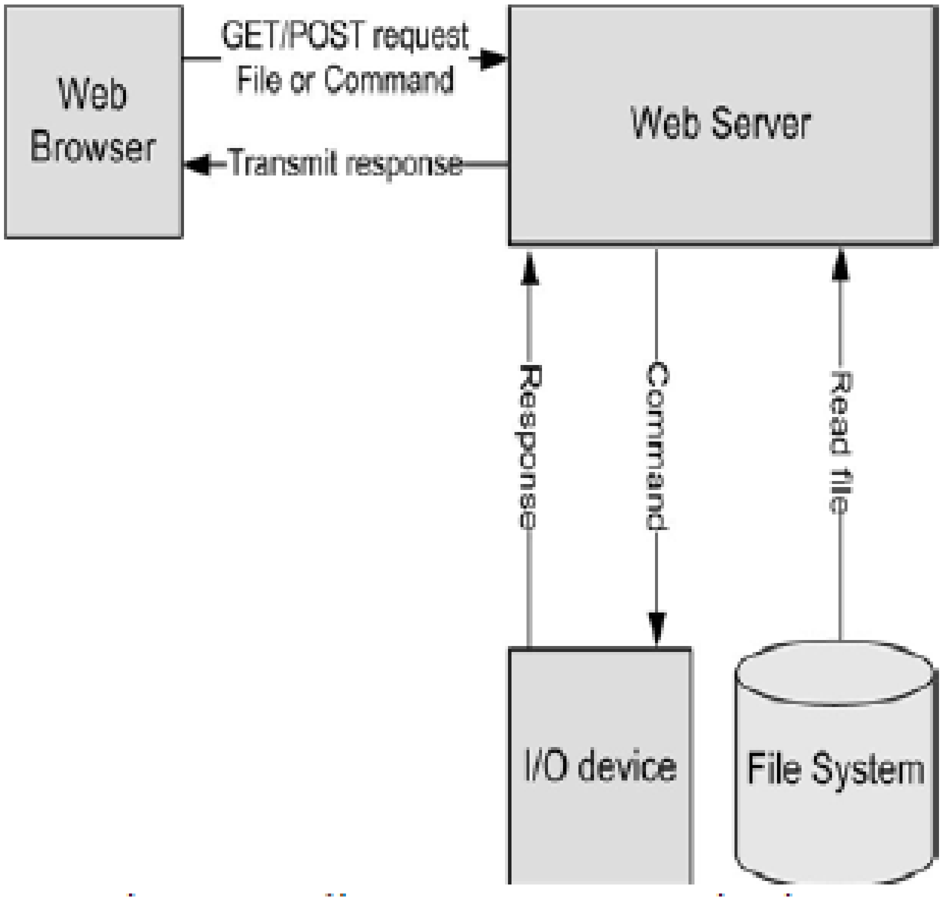

Figure 4-4 Communication between client and server

LwIP TCP/IP stack in RAW API mode is used to develop a webserver using the protocol of hypertext markup language protocol. The design of a web server is which would function as below

- To toggle the LEDs of the Spartan 3E starter kit using the hypertext transfer protocol POST command.

- Uploading an image file in the memory system of the FPGA board using the hypertext transfer protocol POST command.

- To get the content or read the files or access them which are in the memory system of the Spartan 3E starter kit using the hypertext transfer protocol GET command

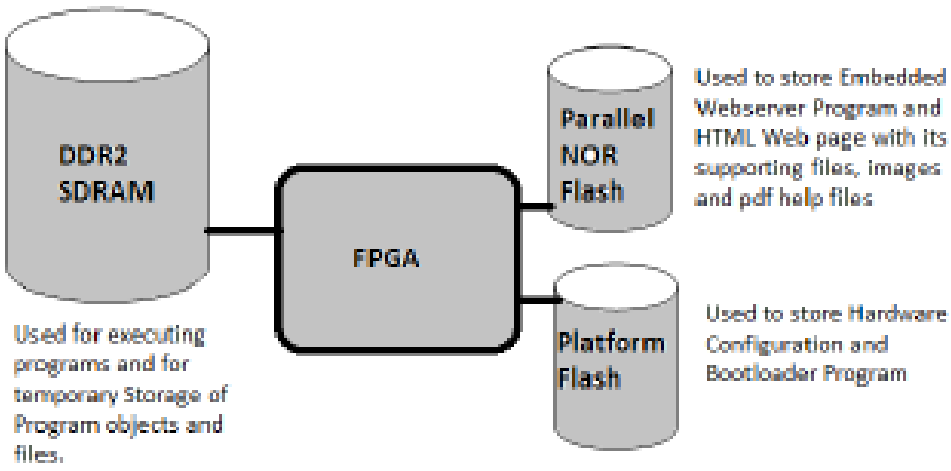

Figure 4-5 Memory Interconnection with FPGA

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2.2 FLOW CHART

The flow chart of the web server which would work is given below.

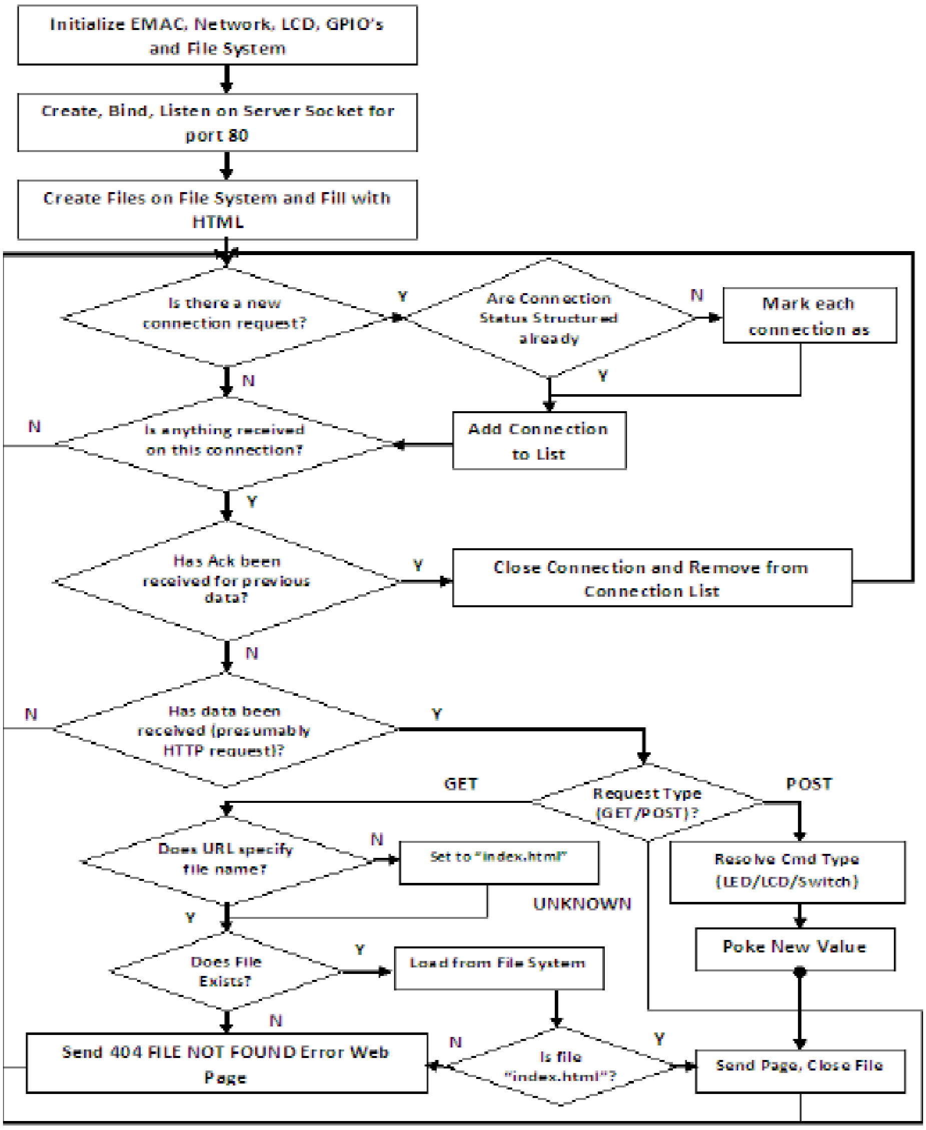

Figure 5-6Flow chart Diagram of working of web server

RESULT & DISCUSSION

CHAPTER 3

3.1 RESULT & DISCUSSION

Given below are the summary, address ports, bus interfaces and the graphical view of the simulation result for a simple FPGA device that includes all the LEDs, IO devices and other peripherals.

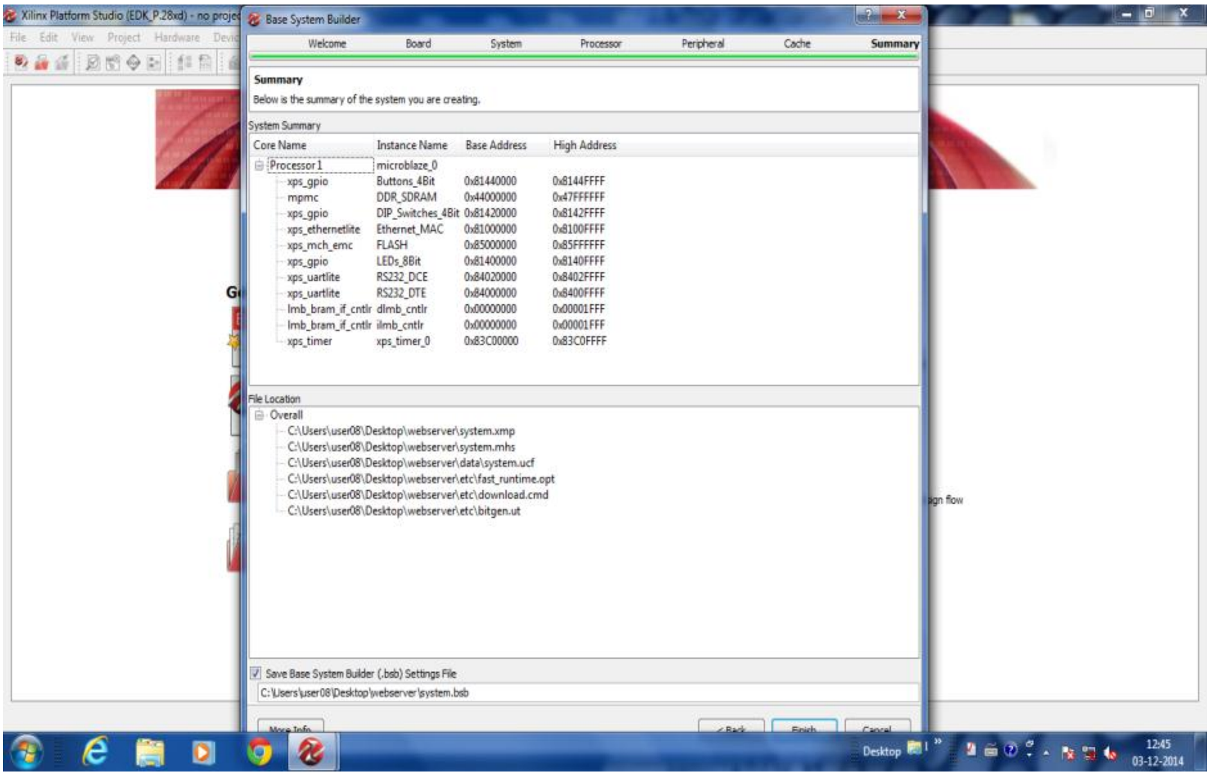

Figure 6-1 Summary of peripherals of a simple microblaze processor based embedded system

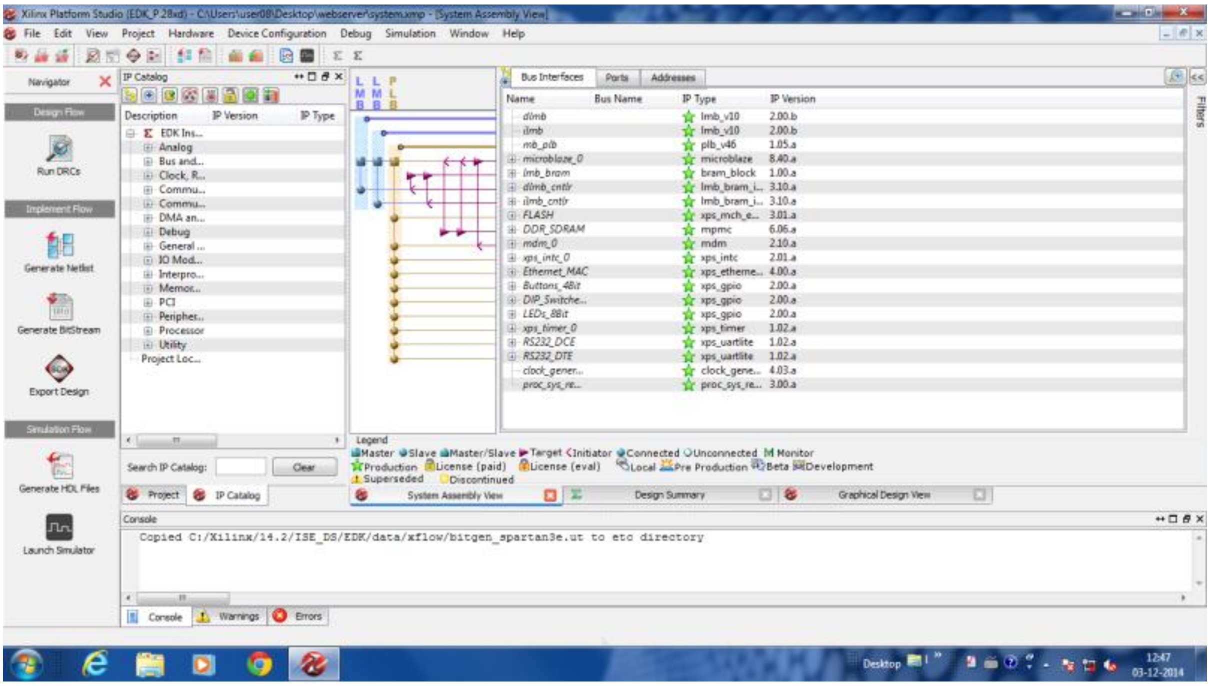

Figure 6-2 Bus interface of peripherals of a simple microblaze processor based embedded system

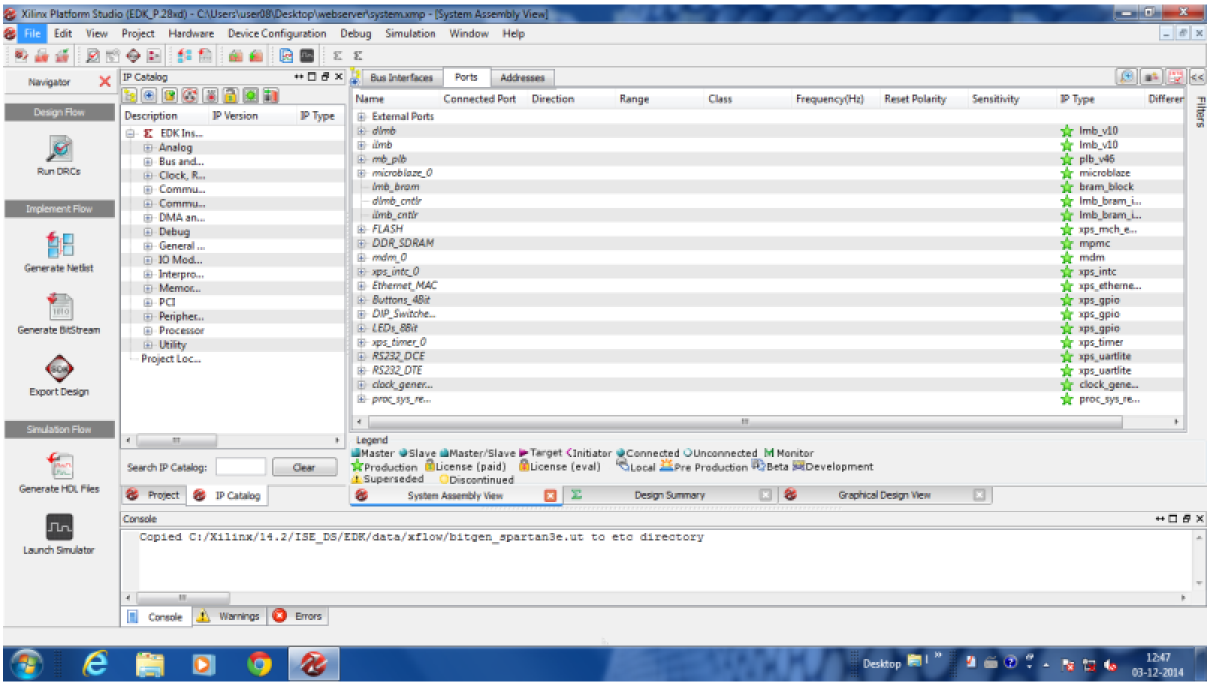

Figure 6-3 Ports of a simple microblaze processor based embedded system

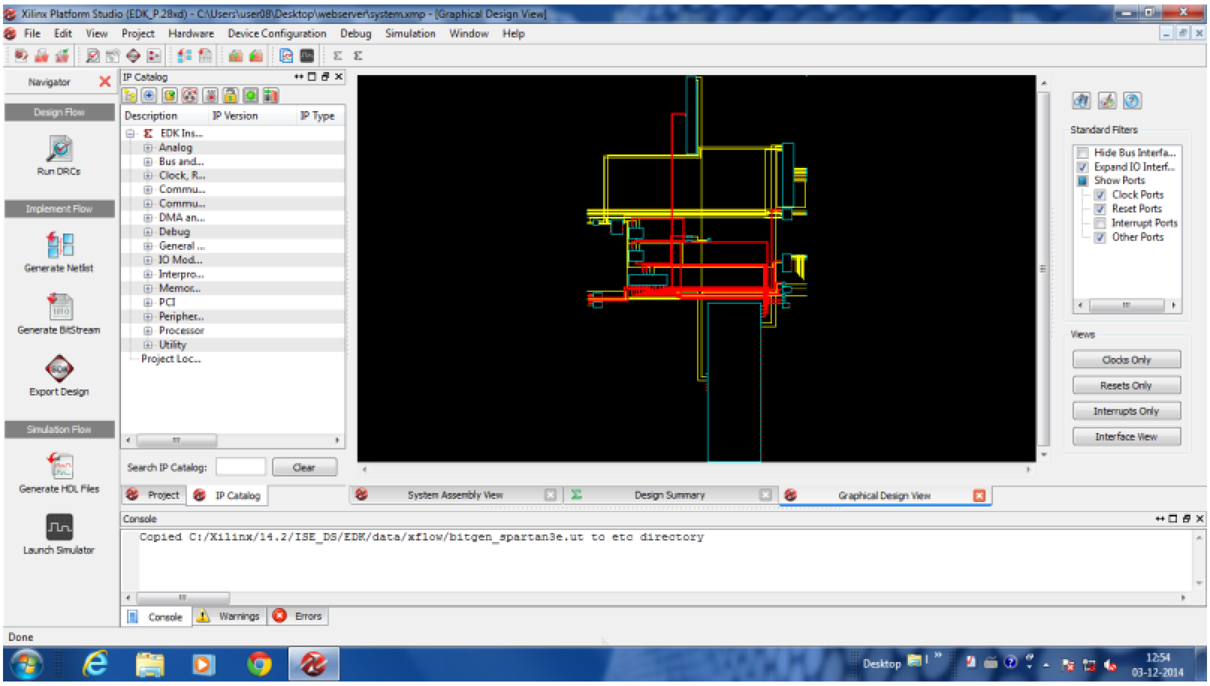

Figure 6-4 Graphical view of peripherals of a simple microblaze processor based embedded system

Below is the test result showing Maximum Transmission Throughput of Embedded Webserver using iperf command line interface in Xilinx Spartan 3E kit.

```
[ ID]  Interval            Transfer    Bandwidth
[324]  0.0- 5.0 sec  14.3 MBytes  24.1 MBits/sec
[324]  5.0-10.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 10.0-15.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 15.0-20.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 20.0-25.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 25.0-30.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 30.0-35.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 35.0-40.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 40.0-45.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 45.0-50.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 50.0-55.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 55.0-60.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 60.0-65.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 65.0-70.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 70.0-75.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 75.0-80.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 80.0-85.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 85.0-90.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 90.0-95.0 sec  14.3 MBytes  24.1 MBits/sec
[324] 95.0-100.0 sec   14.3 MBytes  24.1 MBits/sec
[ ID] Interval        Transfer     Bandwidth
[324]  0.0-100.0 sec    287 MBytes  24.1 MBits/sec
```

Figure 6-5 Maximum throughput of the receiving speed

Below are the web servers for toggling of LEDs, the blinking of LEDs on the FPGA board , and image file uploading

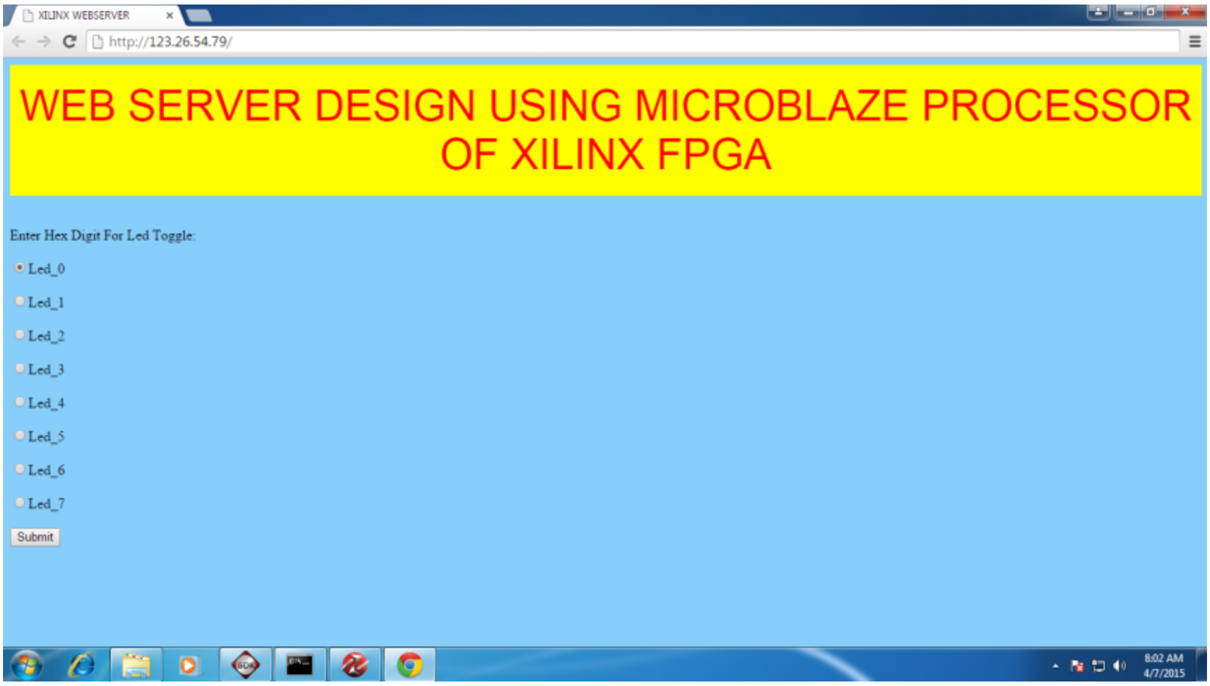

Figure 6-6 Website acting as a web server for toggling of LEDs - I

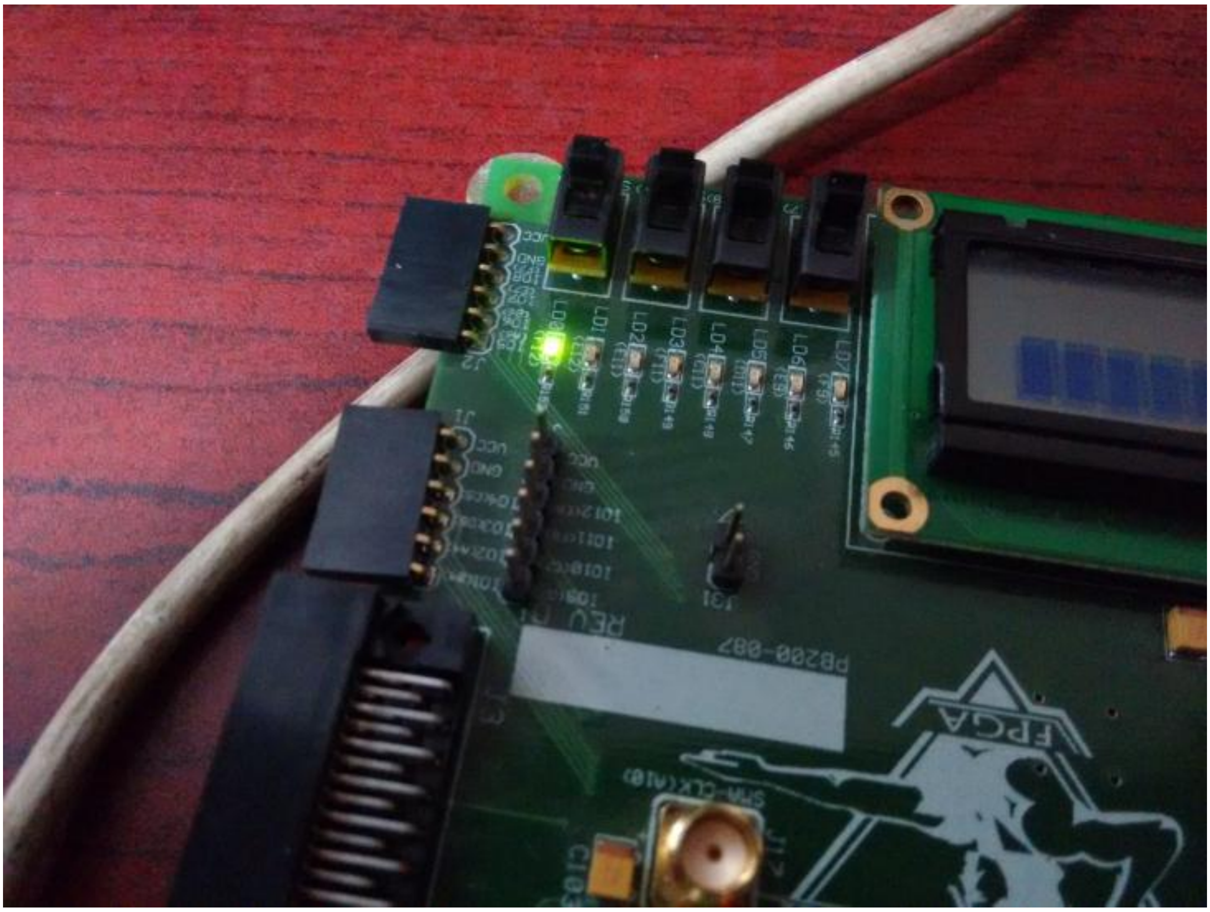

Figure 6-7 Toggling of LED on the Spartan kit-I

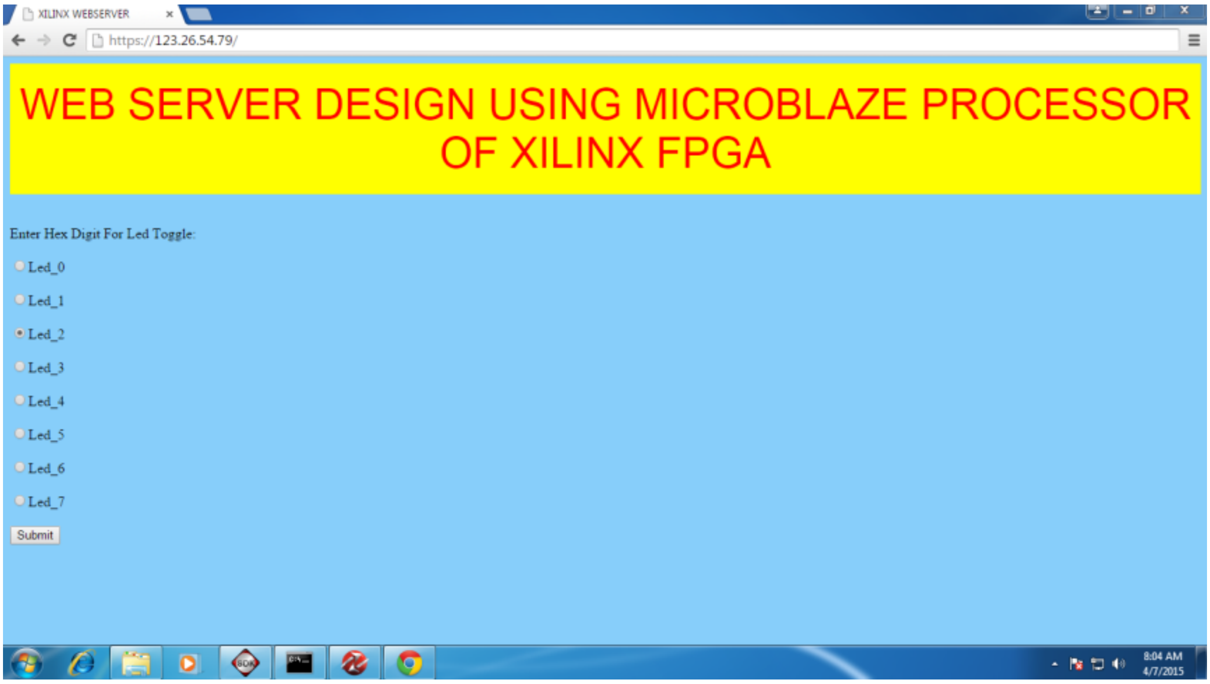

Figure 6-8 Website acting as a web server for toggling of LEDs - II

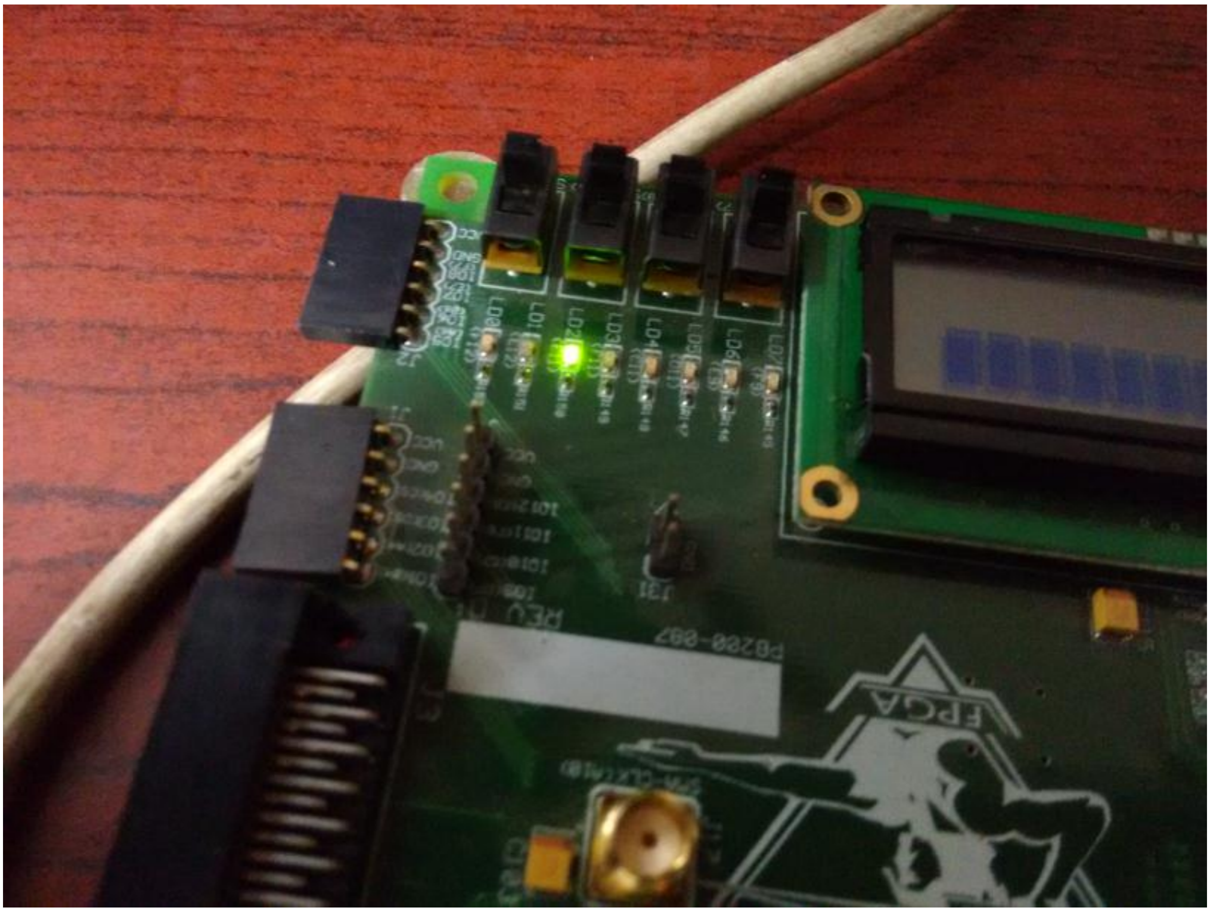

Figure 6-9 Toggling of LED on the Spartan kit-II

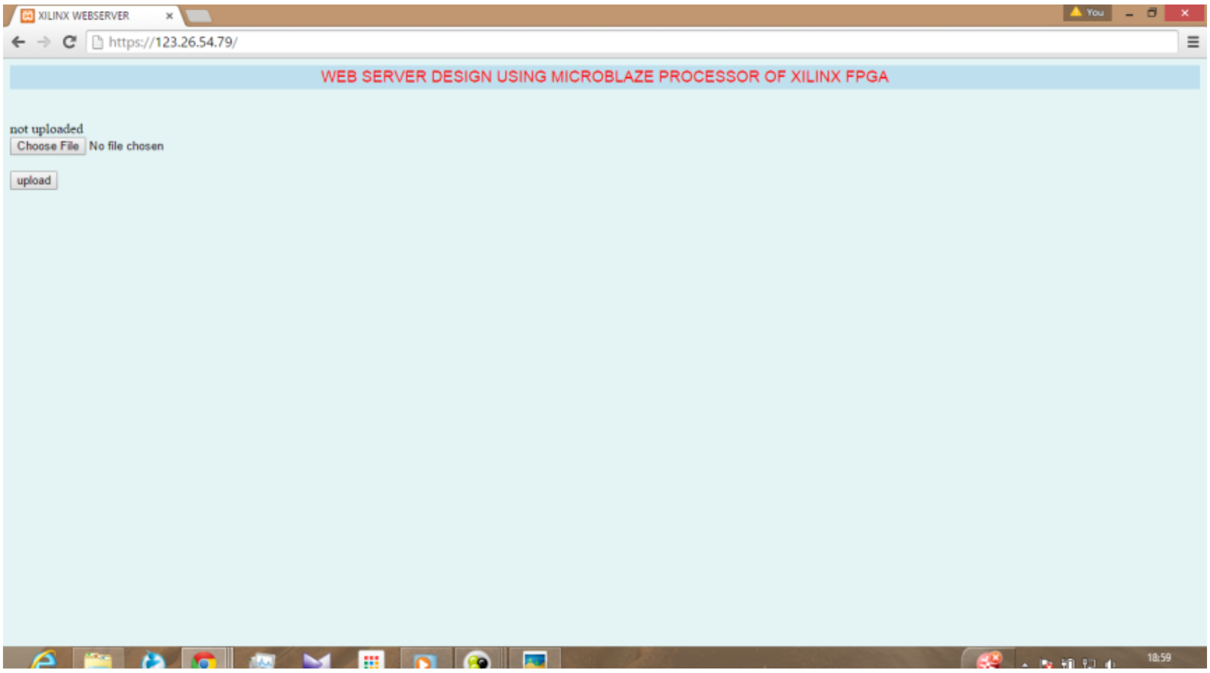

Figure 6-10 Website acting as a web server for image upload-I

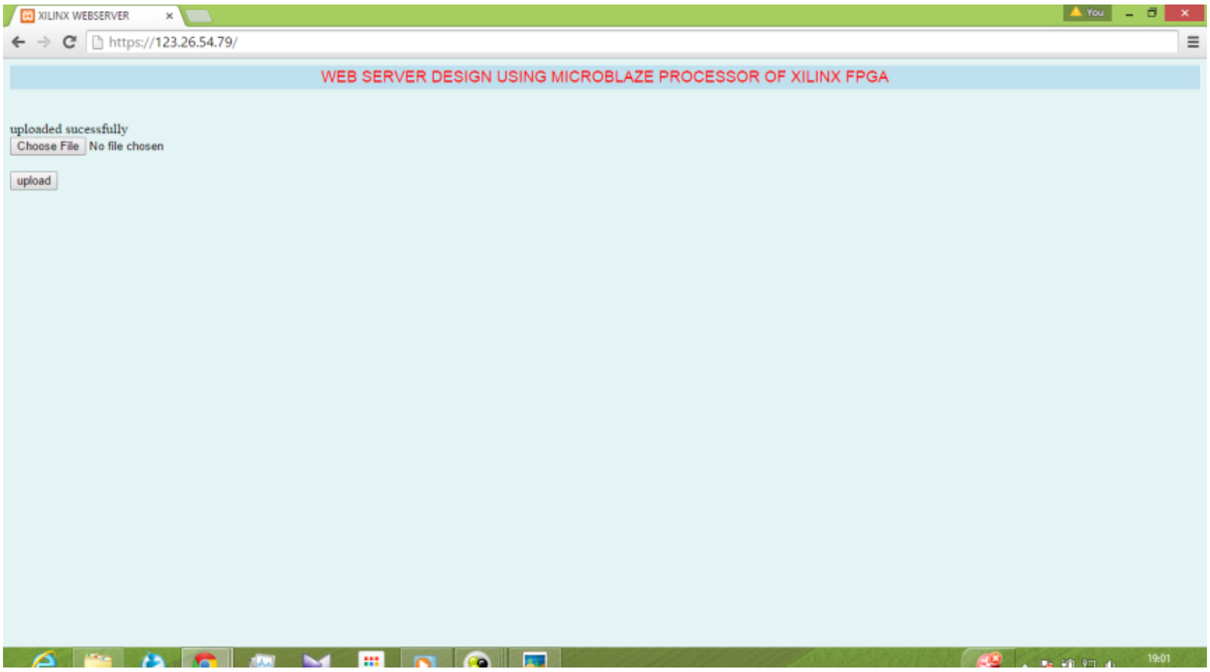

Figure 6-11 Website acting as a web server for image upload-II

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3.2 DISCUSSION

In this project we studied about different aspects of microblaze processor, its features and peripherals. We have menstiones about how a microblaze processor can be very useful towards being developed as a processor to act as a web server. Then we designed simple FPGA processors for the toggling of LEDs of the Spartan kit and saving an image in the memory of it. At last we designed websites which acted as web server to toggle the LEDs of the Spartan kit and upload an image file upon command. Hence we designed the required web server.

3.3 LIMITATION

The limitation of my project is that it cannot be used as a large scale web server as it lacks a very large amount of memory. Again it cannot be used to develop dynamic web pages as it is not php enabled. This type of web server cannot be used for database table handling as it also does not support SQL handling. Lacks most common required security checks, putting emailing option is very complicated and so on.

3.4 FUTURE WORK

The project can be developed as am ftp server, file sharing system. If perfectly designed, it can act as an institute website to keep the information of institute students, required file upload and download, common sharing platform as social networking site and so on. The web server also can act as a central monitoring system for various electronics appliances using internet as a medium in home, office, institution and so on.

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REFERENCE

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